

REMARKS

Please reconsider the present application in view of the following remarks. Applicant thanks the Examiner for carefully considering the present application.

Disposition of Claims

Claims 1-9, 12, 14-22, and 25 are pending in this application. Claims 1, 9, 12, 14, 22, and 25 are independent. The remaining claims depend, directly or indirectly, from claims 1, 9, 12, 14, 22, and 25.

Rejection(s) under 35 U.S.C § 101

Claims 1 and 14 were rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter. For the reasons set forth below, the rejection is respectfully traversed.

The present invention is directed to a method and apparatus for improving the prediction rate of dynamically unpredictable branches. Embodiments of the present invention may use follow-sets, or likely branch target sequences (*see, e.g.*, paragraph [0029] of the specification). If the most probable case in a switch instruction is known, a follow-set may be created including probable next cases in the sequence (*see, e.g.*, paragraph [0030] of the specification). A follow-set is created by grouping sequences of likely cases together such that the sequences have more branches, but the branches are more predictable (*see, e.g.*, paragraph [0031] of the specification).

Independent claims 1 and 14 of the present application recite the steps of (i) processing one of a plurality of cases in response to detection of a branch instruction, (ii) determining a next case from a sequence involving the processed case, where the next case corresponds to one of the plurality of cases, and (iii) processing the next case.

In one exemplary embodiment of the present invention, as shown in Figure 4 of the present application, a microprocessor may detect a switch instruction (202), which leads to a next instruction (210) via one of 3 cases. In this exemplary embodiment, case 1 (204) is predicted as most likely to occur, as it has an associated probability of $P=0.35$. Given that case 1 (204) will occur, it is highly likely that case 2 (207) will occur next, case 3 (211) will follow case 2 (207), and case 1 (204) will follow case 3 (211), as shown by the profiling information in Figure 4. The probability that such a sequence will occur in this example is $P=0.95$. Each of these next cases corresponds to one of the plurality of cases (204, 206, 208). Accordingly, the present invention creates a sequence where not only one case may be processed, but tests for subsequent case conditions may be duplicated from the original cases and created in sequence, following the first case. As shown in Figure 4, these subsequent case conditions are created in sequence, following the predicted case 1 (204), as a subset of the switch instruction. In this manner, a sequence of branches is created with branches that are more likely to occur.

Grouping sequences of cases together that are more likely to occur may increase the rate predicted branches are processed in a processor. Thus, according to the present invention, the high likelihood of a sequence of instructions occurring is taken advantage of by determining a next most likely case condition and processing the next most likely case after processing a first case. The execution of the steps required by independent claims 1 and 14 of the present invention results in an improved rate of branch prediction in microprocessors, as sequences of cases that are more likely to occur may be grouped together. Also, memory may be accessed less, as fewer unnecessary memory transactions may be necessary. As a tangible result, the efficiency of a processor may be increased. Accordingly, the steps recited in claims 1 and 14 are directed to a useful, practical process. Thus, claims 1 and 14 are directed to statutory subject matter, and withdrawal of this rejection is respectfully requested.

Rejection(s) under 35 U.S.C § 102

Claims 1-9, 12, 14-22, and 25 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,412,105 issued to Maslennikov et al. (hereinafter “Maslennikov”). For the reasons set forth below, the rejection is respectfully traversed.

As discussed above, the present invention is directed to a method and apparatus for improving the prediction rate of dynamically unpredictable branches. If a case in a switch instruction is processed, a follow-set may be created including probable next cases in the sequence. Accordingly, independent claims 1 and 9 of the present application require, in part, (i) processing one of a plurality of cases, (ii) determining a next case from a sequence involving the processed case, where the next case corresponds to one of the plurality of cases, and (iii) processing the next case. Similarly, independent claim 14 of the present application requires a program stored on computer-readable media for (i) processing one of a plurality of cases, (ii) determining a next case from a sequence involving the processed case, and (iii) processing the next case.

Independent claim 12 of the present application requires, in part, an apparatus comprising an optimization component that determines a sequence from profile information. Independent claim 22 of the present application requires a program stored on computer-readable media for determining a sequence from profile information, and independent claim 25 of the present application requires an apparatus comprising a means for determining a sequence. Claims 12, 22, and 25 further require that the determined sequence comprises a set of cases to be selectively processed after processing one of a plurality of cases in response to detection of a branch instruction, and that each case in the set of cases corresponds to one of the plurality of cases.

Maslennikov, in contrast to the present invention, fails to disclose at least the limitations of the present invention discussed above. Maslennikov is directed to processing a single alternative based on a probable subset of constants that will lead to that alternative. Given profile data for a multi-way decision statement (*e.g.*, a switch statement), at least one most probable alternative is determined and a conditional statement is created, which is then removed from the multi-way decision statement (*see* Maslennikov, col. 2, lines 45-56). Removed alternatives are placed before the switch statement in order of decreasing probability.

For each possible alternative in a switch statement, there is a set of constants that will lead to that alternative. Collected profile data is used to determine a probable set of switch constants associated with one or more most probable alternatives (*see* Maslennikov, Figure 1; col. 3, lines 42-46). Thus, a subset of constants as described by Maslennikov refers to a set of switch constants associated with the most probable alternatives of a switch statement. Maslennikov does not process a sequence of cases, but rather a single case from a set of constants that lead to one of a plurality of cases. For example, as discussed in col. 4, lines 1-57 of Maslennikov, a switch statement may contain a number of cases (*e.g.*, case const1, case const2, case const3, case const4) that lead to a particular alternative (*e.g.*, alternative1). Based on profile information, alternatives may be removed from the switch statement and placed as a conditional statement before the switch. However, only one of the alternatives is processed (*see* Maslennikov, col. 3, lines 36-57). Maslennikov is completely silent with respect to determining a next case from a sequence involving a processed first case, where the first case and the next case both correspond to one of a plurality of cases.

In view of the above, Maslennikov fails to show or suggest the present invention as recited in independent claims 1, 9, 12, 14, 22, and 25. Thus, independent claims 1, 9, 12, 14, 22,

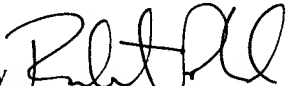
and 25 are patentable over Maslennikov. Dependent claims are allowable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Conclusion

Applicant believes this reply is fully responsive to all outstanding issues and places the present application in condition for allowance. If this belief is incorrect, or other issues arise, the Examiner is encouraged to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 03226/105001; P5810).

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Respectfully submitted,

By  *Pay Lb. 46,479 For*

Wasif H. Qureshi
Registration No.: 51,048
Osha & May L.L.P.
1221 McKinney, Suite 2800
Houston, Texas 77010
(713) 228-8600
(713) 228-8778 (Fax)